Restraint and Handling of Captive Wildlife

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ANZCCART Facts Sheet

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Introduction

ANZCCART's interests cover the 'use of animals for scientific purposes', which includes a very wide range of species, both domestic and wild. Eleven Facts Sheets have now been produced, covering the commonly used laboratory animal species — the mouse, rat, guinea pig and rabbit, as well as the cat and sheep. The previous Facts Sheet covered the care and handling of three representative species of Australian marsupials. A small primate, the Common Marmoset, has also been the subject of a Facts Sheet.

The authors of this Facts Sheet have each had extensive practical experience in major zoological parks and have provided only an introduction to this very extensive subject. The emphasis here is on basic principles and on the use of appropriate, well-maintained equipment with the assistance of competent, experienced staff.

The great majority of wild animals which are maintained in captivity will at some stage require handling and restraint, and because of its very nature this will probably be more difficult and dangerous than it would be with domestic species. Indeed, many situations which would be simple and straight-forward with a domestic animal, become a specialist procedure requiring particular skills and experience when the animal is wild.

This Facts Sheet provides information about the restraint and handling of a variety of captive wildlife. It is divided into two sections:- Part One deals with the general principles of restraining wildlife, including the factors which need to be understood and considered and the equipment which will be required, while Part Two discusses in more detail the capture and restraint of a number of representative taxa.

It is, of course, not possible in this article to cover all possible circumstances and species. The information provided here is meant only as a guide, and for more details the reader is directed to the excellent reviews which have recently been published. These include Bush (1992), Fowler (1995), McKenzie (1993) and Blyde (1994).

Part One — The principles of wildlife restraint

The importance of stress

Wild animals are far more susceptible to stress and injury than domestic species, particularly during capture, handling, restraint and transportation. Even apparently innocuous procedures such as blood collections and clinical examinations can be so distressing to a wild animal as to significantly jeopardise its health and welfare. In addition, many wildlife species are potentially dangerous to the handler, and so human safety must also be taken into consideration.

Consequently, the aim of every capture and restraint procedure must be to minimize the stress on the animal, and at the same time maximize the safety of the handler. This means planning ahead and taking account of a number of important factors. These will include;

- a thorough knowledge of the species to be handled, including its behaviour, reaction to stress, ability to defend itself, and the appropriate physical and chemical restraint procedures;

- a consideration of why the animal needs to be handled, including exactly what is to be done to it. Is the procedure likely to be painful? How long will it take?

- the equipment and facilities needed - everything should be checked and made ready **before** the animal is captured;

- the restraint procedures to be adopted. Is physical restraint sufficient, or will chemical restraint also be required? This will depend upon the answer to the first two points above;

- when is the best time to undertake the procedure? Early morning or late afternoon might be cooler and therefore better for the animal; and

- the recovery conditions. Animals which have been anaesthetised will need to have an appropriate quiet, dark environment in which to recover, free from disturbance but where they can still be monitored.

Table 1.	Captive animals and equipment required
Small carnivores	Nets, pole syringes, blow dart equipment, crates, squeeze cage
Hoofed stock	Projectile guns and darts, blow dart equipment, crates
Small mammals (e.g. primates)	Nets, surgical gloves, pole syringe, blow dart equipment, crates, squeeze cage
Reptiles	Nets, bags, plastic tubes, snake tong, snake hook
Amphibians and fish	Nets, gloves

Many of these factors simply require the handler to display common sense, but appropriate skills and experience are also vital. It may also be appropriate to seek further advice or expert help, for instance from a local zoo or fauna park, and to be aware of the latest equipment and techniques in this area (see Table One above). The handler should always be prepared to abandon a capture procedure if the animal becomes too stressed or it becomes apparent that the equipment or facilities are inadequate.

The equipment

The appropriate equipment to be used for each group of species is discussed in Part Two and indicated in Table One. The most commonly used equipment includes the following items:

For physical restraint

Where physical restraint is appropriate, the equipment will probably include thick gloves (for instance welder's gloves), hessian or linen bags, hoop nets and crates. Most of this equipment can be easily obtained or made, but it is important that all the equipment used is suitable for the particular species and capture procedure in question.

A hoop net resembles a giant butterfly net, with a long, strong handle fixed to a metal or fibreglass hoop supporting the net. This net should be made of fine, soft, strong mesh and be deep enough to allow an animal to become trapped in its folds as the operator twists the handle. It can be home-made or purchased commercially. Crates can be used to hold and transport conscious animals, or as recovery boxes for anaesthetised individuals. They should be big enough for an animal to stand up and turn around, while also allowing the operator to observe it easily.

Chemical restraint — remote drug administration systems (RDAS).

Projectile syringes or darts are an extremely useful means of injecting drugs intramuscularly (i/m) in captive wild animals. They can be used on a wide range of species from small carnivores and primates to the largest of ungulates.

There are four basic types of RDAS
i) pole syringes;
ii) blowpipes;
iii) dart pistols; and
iv) dart rifles.

These four systems are reviewed more thoroughly by Bush (1992) and Blyde (1994) as well as by McKenzie (1993). All have certain advantages and disadvantages and no one system meets everyone's needs for all species. As Bush (1992) concludes, 'The choice of system depends upon the size of the animal, the amount of the drug to be injected, the distance to the animal, and most importantly, personal experience'.

Pole syringes are cheap, safe and quiet, but are only useful in small cages, crushes or when the animal is physically restrained.

Blowpipes are the cheapest and probably the safest RDAS. They are commercially available, but can also be home-made. Reddacliff (1979) and Tribe and Middleton (1988) both describe how to make darts simply and quickly. However, blowpipes have a range of only 10 to 15 metres and by their very nature require considerable practice to use effectively.

Dart pistols are more accurate and have a greater range than blowpipes - being useful to about 20 metres. However, they are more expensive and their greater power also means greater danger for the target animal.

Dart rifles provide the greatest range and accuracy - up to 50 metres. Consequently they are the system of choice for large enclosures or open range situations.

The drugs

The characteristics of an ideal drug for sedating or immobilizing wild animals can be summarised as follows. It should:

- be concentrated enough so that an effective dose does not exceed the quantity that can be carried in one dart (usually less than 3ml);
- be suitable for intramuscular injection, and hence non-irritant at the site of darting;
- provide rapid and smooth onset resulting in sufficient

immobilization;

- have a wide safety margin. In many cases, the exact weight and health status of the target animal will not be known until after it is immobilised. Consequently, drugs with a wide safety margin and which have minimal effects on the cardio-respiratory system are to be recommended; and

- provide smooth and rapid recovery from immobilisation.

With these characteristics in mind, the following drugs are those most often used.

Diazepam (Valium-Roche; Pantin Injection - Parnell Laboratories) is a benzodiazepine tranquillizer which produces anxiolytic, sedative, skeletal muscle relaxant and anticonvulsant effects (Booth, 1994). It can be a very useful sedative in a range of species, particularly when capturing wild animals by hand. The usual dose rate is 0.5-1mg/kg intravenously or 1-2mg/kg i/m, although slow i/v administration (5mg per minute)is the most reliable and repeatable method of administration. Orally administered diazepam is not recommended because it tends to produce unreliable results. Diazepam is extremely safe in short-term usage and can be followed by injectable or inhalation anaesthetics.

Zoletil (Zoletil-Virbac). This a fast-acting anaesthetic which can be used in a wide range of species. It is a combination of two drugs - tiletamine (a ketamine-like drug) and zolazepam, which is closely related to diazepam. Zoletil provides a rapid induction, excellent muscle relaxation and hence immobilisation, with a wide safety margin and a smooth recovery. As it is highly soluble in water, only a small injection volume is required for effective dose, even in larger animals. As such it is probably the most convenient and widely used agent available.

Recovery usually takes two to four hours but can vary amongst individuals (for instance it can be prolonged further in tigers). It is vital during this time that the animal is allowed to wake up in a quiet, dark place so that the chances of it injuring itself are minimised.

Ketamine / Xylazine combinations (Ketalar-Parke Davis; Rompun- Bayer). For many years ketamine has been one of the most commonly used dissociative anaesthetics for a broad range of species. It can be given either by i/m or slow i/v injection, and is used mainly in combination with xylazine, which is a derivative of thiazine hydrochloride and acts as a sedative with some muscle relaxant properties. However, it should be used carefully, because it also produces hypotension and brachycardia, and if animals are highly excited the precipitous drop in blood pressure can be fatal (Blyde, 1994).

When ketamine and xylazine are used together, the action of one drug complements and even enhances the other. Hence lower doses are needed to provide more effective and safe chemical restraint (Tribe and Middleton, 1988). The effects seen include pronounced general analgesia, slight hypotension and brachycardia, and slower breathing. Anaesthesia can be prolonged by topping up with ketamine alone, and recovery is usually smooth and quiet. These qualities make this drug combination one of the best forms of chemical restraint available.

Halothane (Halothane M&B - May & Baker; Fluothane - ICI). A non-explosive, halogenated alkane, halothane is the most widely used inhalation anaesthetic in Australia. It can be used successfully with the majority of wild animal species, and due to its pleasant odour most tolerate mask induction well. It is compatible with all commonly used injectables, which can be employed as inducing agents.

However, halothane does have disadvantages. It sensitizes the myocardium to catecholamines and hence can induce arrhythmias, and it can induce lung and liver damage due to toxic metabolites. Consequently, unnecessarily deep anaesthesia with halothane should be avoided, and where possible isoflurane used instead.

Isoflurane (Forthane - Abbot). A non-explosive halogenated ether, isoflurane is an inhalation anaesthetic of low solubility in blood and high potency. It is less widely used than halothane because it is about four times as expensive, but it does have a number of advantages. It is metabolically stable and thus induces far less organ toxicity and myocardial sensitization, while still providing rapid induction, recovery, depth regulation, good muscle relaxation and analgesia. Consequently, it is the inhalation anaesthetic of choice, and should always be used with valuable animals, especially small mammals and birds.

However, isoflurane requires its own precision vapourizer - it is not appropriate to use one which is also used for halothane because the sticky preservatives in halothane will interfere with its metering.

Medetomidine (Domitor - Ciba Geigy). This is a potent sedative and analgesic which can be used in a wide range of species. It is particularly useful for minor and routine procedures such as immobilizations, clinical examinations, blood collections, minor surgery and as a pre-anaesthetic. It can be given either by i/v or i/m injection, and the duration and degree of its sedation and analgesic effects depend on the dose administered.

Medetomidine shows marked synergism with other anaesthetics, particularly ketamine, producing deep anaesthesia. It has a very potent ability to reduce the dose requirements of inhalation anaesthetics such as halothane and isoflurane.

However, medetomidine also causes a decrease in heart rate and body temperature, and so treated animals should be kept warm for up to 12 hours after sedation.

Perhaps the greatest advantage of medetomidine over other sedatives is that it can be reversed with **Antisedan** (Atipamezole - Ciba Geigy). This drug is given by intramuscular injection and the first signs of arousal occur within two to five minutes. The animal is usually able to stand and walk normally within 10 to 15 minutes. This is particularly useful with timid animals which may injure themselves by panicking during a prolonged recovery.

Detomidine (Dormosedan - Ranvet). This is another potent, dose-controlled sedative and analgesic which can also facilitate a wide range of procedures including examinations, blood collections, minor surgery, transportation and the control of pain. It is particularly useful for ungulates and can be given by i/v or i/m injection.

Etorphine (Large Animal Immobilon - C-Vet. Vet Products). Etorphine is designed primarily for use in horses, but has also been used successfully in a wide range of wildlife species. It is actually a mixture containing 2.45 mg etorphine hydrochloride with 10 mg acepromazine maleate per millilitre. It can be given by either i/v or i/m injection, and is particularly useful for darting ungulates. In some animals, especially equids, immobilization with Immobilon causes stiffness, muscle tremors and some respiratory depression. For this reason they should be monitored closely, and the effect reversed quickly if necessary. The effects of etorphine usually last for 45 to 90 minutes.

The action of Immobilon can be reversed by diprenorphine (Revivon - C-Vet. Vet. Products). A quantity of diprenorphine equal to the total volume of Immobilon injected should be given i/v as soon as possible after the required period of restraint is complete. Most animals regain their feet within minutes of this injection. Injection of diprenorphine antagonises only the actions of etorphine, hence analgesia is lost but sedation due to the acepromazine is unaffected.

Large Animal Immobilon is an extremely potent neuroleptanalgesic which is highly toxic to humans. For this reason its use is restricted to specially licensed registered veterinarians.

In humans it causes dizziness, nausea, pinpoint pupils, respiratory depression, cyanosis, hypotension, loss of consciousness and death. In the event of accidental injection, spillage on the skin or immediate clothing, or splashing into the eyes or mouth, immediate medical aid is essential. Spillage or splashing may be treated by the immediate washing with copious quantities of water but it must never be assumed that this will be sufficient to prevent significant absorption. It is vital that adequate respiration and heart beat be maintained, if necessary by standard techniques of cardiopulmonary resuscitation, until medical help arrives. While medical help is awaited, antagonists must be used if signs of narcosis become evident. The recommended procedure is to inject naloxone (0.4 mg/ml) in one ml doses intravenously or intramuscularly at intervals of two to three minutes until signs of improvement are observed. Etorphine should never be used without a surplus of naloxone being available; diprenophine is not suitable for use in humans.

Common sense dictates that anyone wishing to use Immobilon to induce anaesthesia in ungulates should take precautions to avoid accidents and be thoroughly familiar with the procedures to be adopted should they nevertheless occur. It should never be used unless another qualified person is present and supplies of naloxone are readily available.

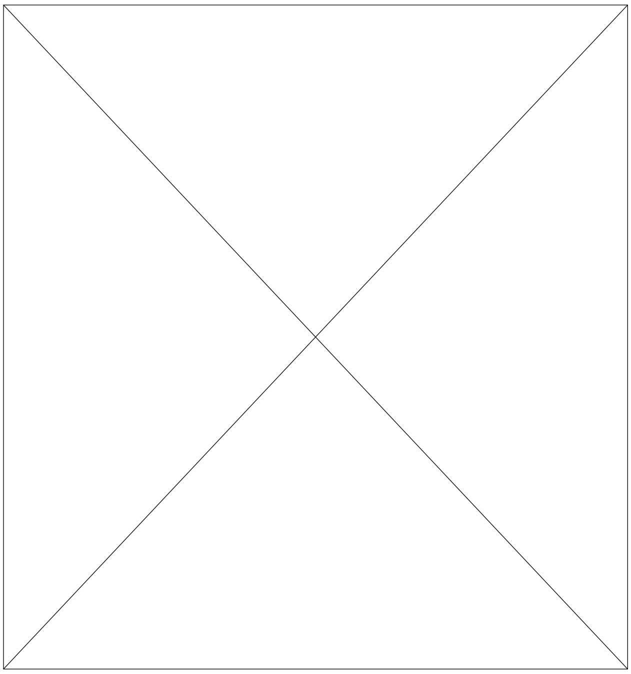

Figure 1. An injection of insulin given with the assistance of a squeeze cage to restrain a chimpanzee (photo: Taronga Zoo).

Part Two — Examples of the restraint and handling of captive wildlife

Medium-sized primates

Considerations:

The intelligence, speed and dexterity of primates can make them very difficult to restrain, and, once they have experienced the procedure, they can become very difficult to approach. Primates are able to thwart capture with a hoop-net by pushing it away or by holding on to it, and can escape from a cast net by walking out from under it or throwing it off. These factors often make immobilisation by remote injection the preferred method of capture for even minor manipulations or examinations if an efficient crush is not an integral part of the normal handling facilities.

When the alpha animal (usually male; female in some species) is removed from a social group, the subordinate animals will vie for the dominant position, and it may not be able to regain its dominant position when returned. If a primate is returned within three days it will usually be accepted back into a group, but if it is re-introduced more than a week later, it is likely to be attacked and possibly killed. Animals may be punished for even short absences: a patas monkey that had its teeth broken during a routine capture with a hoop net had them capped by a dentist. When it was returned to the group later the same day, it was set upon by the other members of its group and had its teeth knocked out for the second and final time. Therefore, it is very important to include the risks of social disharmony and of attack at re-introduction into the consideration of removing an animal from a social group for treatment or for an elective procedure. There are several procedures that have been

successful in introducing new animals or re-introducing former members into a group. A crab-eating macaque that had been kept in a suburban back-yard in an aviary-sized cage on its own for over twenty years was eventually accepted into an established group even though when it arrived it displayed severe and classic signs of social deprivation (self-mutilation and other bizarre behaviours) and physical deformities. Immobilised animals should be allowed to recover completely in isolation before being returned to a group. Non-human primates are unable to dissipate heat as efficiently as humans and the risk of hyperthermia should always be guarded against and compensated for whenever restraining them (e.g., cooling the facility, carrying out procedures in the cool of the morning or evening, or during the cooler months of the year.

Precautions:
Always wear protective clothing and equipment when handling primates (surgical gloves, overalls or surgical gown, mask), and have a protective level of antibodies to hepatitis B through vaccination and booster injections.

Take care if trying to restrain or immobilise Old World primates with bulging cheek pouches: food stored in the pouches may dislodge and become inhaled during the excitement of the capture or during manipulations. Check and empty the cheek pouches as soon as an animal is anaesthetised.

The only gloves that should be worn when handling primates are surgical gloves as a barrier to infection. Heavier gloves are not recommended because of the loss of sensitivity and dexterity, increasing the risk of injury to small animals and to the handler with larger ones. Gloves give a false sense of security.

Methods:
Primate holding facilities should have an efficient squeeze cage incorporated into the design so that the animals become used to moving through it routinely. It can then be used to restrain an animal for quick procedures (e.g., a course of daily antibiotic injections) or to inject an immobilising agent.

If a squeeze cage is not an option, it is usually most efficient to net primates of mass up to 15 kg. The diameter of the hoop should be appropriate for the size of the animal and the mesh should be small enough not to allow the head or a limb to protrude. Try to minimise the number of people entering an enclosure of monkeys, but it is advisable to have an assistant to ward off attack. Otherwise one or more monkeys may jump directly at a handler in an offensive or defensive response or to gain access to a vantage point for escape. Some texts advise the use of a fencer's mask if the animals are known to jump at the handler, but, if the handlers are skilled, this may limit visibility and manoeuvrability and so increase the risk of injury to the animals and handlers.

Once netted, small monkeys up to five kg may be swiftly grasped behind the head to avoid injury. The arms of larger primates may be gripped above the elbows and pulled behind the back. Although many texts advise that simple examinations and procedures can be carried out with the primate in manual restraint, the aim is to minimise the stress for the animal and handlers, and, except for extremely quick procedures, anaesthetising it with isoflurane delivered via a face-mask placed over the face while the animal is held in a net or loose-weave sack is preferable. Ketamine (8-15 mg/kg i/m, a higher dose with a smaller mass) or tiletamine/zolazepam (three to six mg/kg i/m, a higher dose with a smaller mass) can be used if isoflurane (or, as a second choice, halothane) is unavailable.

Darting animals below 15 kg mass is not recommended. There is a high risk of injury (impact trauma, damage to an eye, the face, body cavity or internal organ) and the animals are too fast and small to be good targets.

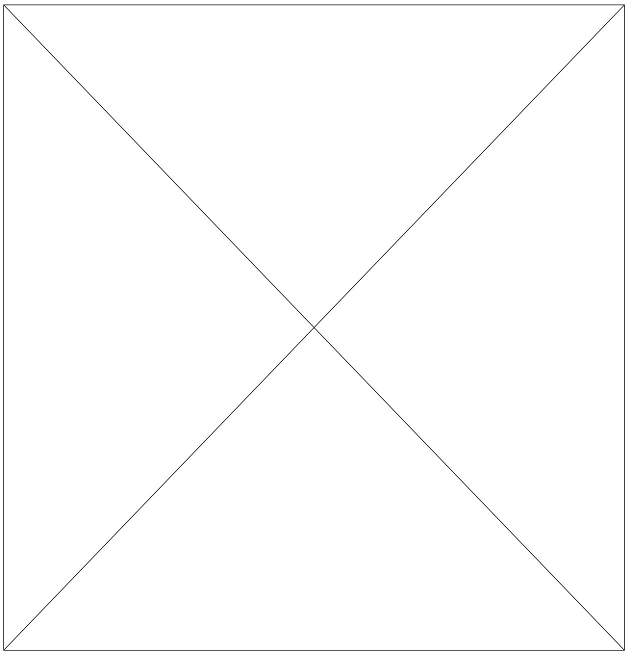

Figure 2. Stretcher transport of a chimpanzee after sedation (Photo: Taronga Zoo).

Great apes:

Considerations:
Great apes can learn to differentiate between attendants and veterinarians or researchers, and between veterinarians that are there to observe and those who want to immobilise a member of the group. They are adept at making this difficult by covering parts of their bodies they recognise as targets with their hands, face or infants, throwing missiles at their antagonist (faeces always seems to be handy), or moving rapidly to avoid them providing an easy target. Successful darting almost always involves being able to distract them for the few seconds it takes to aim and discharge.

Frequent observation or positive interaction between the animals and the veterinarian or person who carries out remote injections can be used to disguise attempts at remote injection, especially if this can be accomplished with a short, easily hidden blow-pipe or gas-powered pistol. Attempts at chemical immobilisation

that become drawn-out cause great stress and hyperexcitability in the target animal(s), increasing the risks of poor induction, the need for topping up, hyperthermia and other complications, thus endangering the animal's health. If an attempt at immobilisation becomes too dramatic, it may be best to abandon it and try again later if the procedure can be postponed. The advantages of this should be weighed against the revelation to the animals that being a difficult target may be rewarded with avoidance of the stressful procedure.

Human stretchers can be used to transport anaesthetised large primates, with a strong net over the animal and which is securely attached to the stretcher. Place them in a stable side position to maintain a straight airway until they are to be positioned for a particular procedure. Raise the head and keep the neck straight by placing it on the crook of one of the arms, and bend the upper leg at the hip and knee to help stabilise the position. The head should face down so that any excess saliva or vomitus will drain out of the mouth. Place them in this same positioning for the recovery on a soft, dry bedding of shredded paper or similar.

Precautions:
Gibbons, siamangs and great apes have laryngeal air sacs for modulating vocalisations. These can extend from the larynx to the front of the thorax, and to the waist and the mandible near the ears in orangutans. If infected at the time of immobilisation, accumulated pus can flow into the larynx and be aspirated into the lungs if the animal is placed in ventral recumbency.

Whenever possible, immobilise primates where they cannot climb to a dangerous height from which they can fall when they lose consciousness.

Methods:
Almost any manipulation of a great ape (gorilla, orangutan, chimpanzee) will require chemical immobilisation. Individuals can be trained to accept low-impact procedures such as routine insulin injections for diabetics, or repeated blood collections for pharmacokinetic studies. Massive squeeze cages can be built but the stress and risks of injury associated with their use will usually favour the use of chemical restraint.

The tiletamine/zolazepam combination (two to three mg/kg i/m) is recommended. The animal must first be isolated (preferably out of visual and auditory range) to avoid stress to other members of the group and attack by them when it starts being affected by the drugs. The use of blow-pipes to inject great apes can be very hazardous to the user and a dart pistol is recommended, although, with experience, a short blow-pipe can be the quickest and most flexible technique. The dart should impact perpendicularly to any obvious and sufficiently large muscle mass, away from major blood vessels or nerves (e.g., avoid the upper inner thigh near the groin). Avoid hair masses which can prevent a dart from penetrating by deflecting or impeding it.

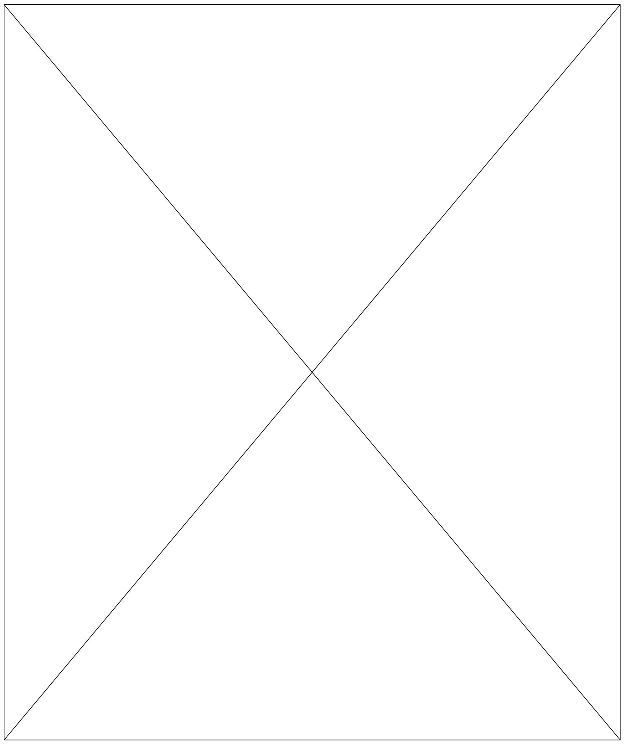

Figure 3. Use of a capture net to restrain a medium sized carnivore which has been sedated with ketamine (Photo: Taronga Zoo).

Medium-sized carnivores

Considerations:
If an animal cannot be caught in a net within a reasonable time, the attempt may have to be postponed to avoid hyperthermia or trauma (physical or physiological). Attempts at capture should always be carried out during the cooler times of the day or during the cooler months.

Some texts recommend atropine be administered (0.04 mg/kg s/c or i/m) when anaesthetising a carnivore, but cardiologists advise against the routine use of atropine and it can effectively be administered once excessive salivation is considered likely to cause a problem.

Ketamine may produce cataleptoid side-effects in some felids and other carnivores, and some felids (especially tigers with other cyclohexamine anaesthetics) may show obvious signs of depression for days. Ketamine often causes excessive salivation, particularly in felids. The use of atropine to control this can cause a serious tachycardia and, because the swallowing reflex is retained, is unnecessary.

Precautions:
Do not lift an anaesthetised felid by the scruff of the neck as it may cause severe laryngospasm.

Methods:
Carnivore holding facilities should have a trap box or an efficient squeeze cage incorporated into the design as described above for primates. Otherwise most carnivores of mass up to 20 kg can be netted once they have been isolated. It is most efficient to have two to three catchers with hoop nets strategically placed in a large enclosure

before a single carnivore is released from a holding cage or den into the enclosure.

Tiletamine/zolazepam (2-10 mg/kg i/m) can safely be used in most carnivores, but appears to be inferior to a medetomidine/ketamine combination (50-100 mg/kg and two to five mg/kg respectively; the effects of medetomidine can be reversed by atipamezole), significantly so in tigers. Use an immobilising dose towards the high end of the indicated range to reduce the need to top up, which can significantly prolong recovery. The eyelids usually remain open with tiletamine/zolazepam, and the corneal, palpebral, laryngeal, pedal and pinnal reflexes persist, even during deep anaesthesia, so they cannot be used to indicate the plane of anaesthesia. Excessive salivation is common but can be controlled with atropine if it becomes problematic (the intact reflexes will normally cause excess saliva to be swallowed).

Medium-size ungulates

Considerations:
Except for simple procedures like herding or vaccination in a raceway with habituated animals, wild, non-neonatal ungulates should always be heavily sedated or anaesthetised for any form of manipulation or examination.

The rumen cannot be emptied prior to restraint or anaesthesia and regurgitation and aspiration of ruminal contents is a major risk in the restraint and anaesthesia of ruminants (some anaesthetics cause partial to total relaxation of the cardiac sphincter). However, fasting for 24-36 hours prior to anaesthesia will decrease the ruminal load and the likelihood of regurgitation.

Use an immobilising dose towards the high end of the indicated range to avoid excessive running and injury to handlers. The longer an animal struggles against the early effects of a drug, the greater the risks of hyperthermia and fatigue.

Drugs used to immobilise ungulates should be efficiently reversible to minimise the risks of ruminal aspiration and trauma from repeated falls during recovery.

Precautions:
Do not immobilise ungulates during hot weather, and have plenty of cool water or some other means of rapidly cooling a hyperthermic animal if it is indicated.

Approach an immobilised ungulate quietly, carefully and grab it firmly (by the horns if they are present) from behind. Otherwise it may jump up and run further, causing unnecessary stress and perhaps injury.

Ensure the neck and head are always above the level of the rumen with the head facing down so that any fluid in the mouth will drain. This is especially important while the animal is being moved or manipulated, and requires the animal to be manually restrained soon after it succumbs to the immobilising dose. The risk of a drugged animal being attacked by conspecifics also makes rapid manual restraint imperative. Keep the legs tucked close to the body to prevent kicking but do not put pressure on the abdomen. Protect the eyes from the sun, drying out and from dust.

Sharp horns can be covered with rubber hosing or similar to minimise the risks of trauma to handlers.

Methods:
The immobilising drug of choice for non-domestic ungulates is etorphine. Anaesthesia can be maintained for lengthy procedures by delivering halothane or isoflurane via an inflated endotracheal tube.

Etorphine is reversed by an intravenous injection of diprenorphine at double the dose of etorphine used. Reversal usually occurs within one to four minutes. Animals may experience renarcotization a few hours after reversal (although I have not observed this with captive animals). Some wildlife veterinarians give an extra 50% of the reversal dose by s/c injection to reduce this risk. If using naloxone to reverse the etorphine, administer half the dose i/v, a quarter i/m and a quarter s/c.

The animal should be supported until reversal is adequate, which is usually indicated first by the ears flicking forward (showing a sudden return to alertness), quickly followed by increase muscle tension and an attempt to rise (usually successful). A hasty retreat should be made then so that the animal is allowed to recover gradually and not stimulated to flee.

Reptiles

Considerations:
Respiration in reptiles is slow, one to two breaths per minute, they breath-hold and the heart beat can be difficult to detect. In snakes the heart beat can be palpated or seen about 20-30 percent of the snake's length from the head.

There are no reliable reflexes to monitor the depth of anaesthesia, but the degree of tail relaxation, respiratory and cardiac rates, response to pain, righting and corneal reflexes, and mucous membrane colour (but not in chelonians, which become pale, even under light anaesthesia), may be used in some species to indicate anaesthetic depth.

There is no evidence that lowering a reptile's temperature to as low as 4^{o}C reduces its sensitivity to pain. It merely lowers its metabolic rate and hinders it from escaping painful stimuli.

To achieve the optimal and most consistent results for induction, maintenance and recovery, and to maintain the animal's health, anaesthesia should be carried out within the species' preferred temperature range. If this is unknown, 26-32^{o}C is adequate.

Reptiles should be fasted for 24-48 hours prior to anaesthesia to prevent putrefaction of ingesta because of reduced activity in the gastro-intestinal tract. A full stomach may also compress the lungs or result in regurgitation.

The muscular laryngeal sphincter in reptiles at rest is closed (it is open in mammals and birds), making intubation of some reptiles difficult.

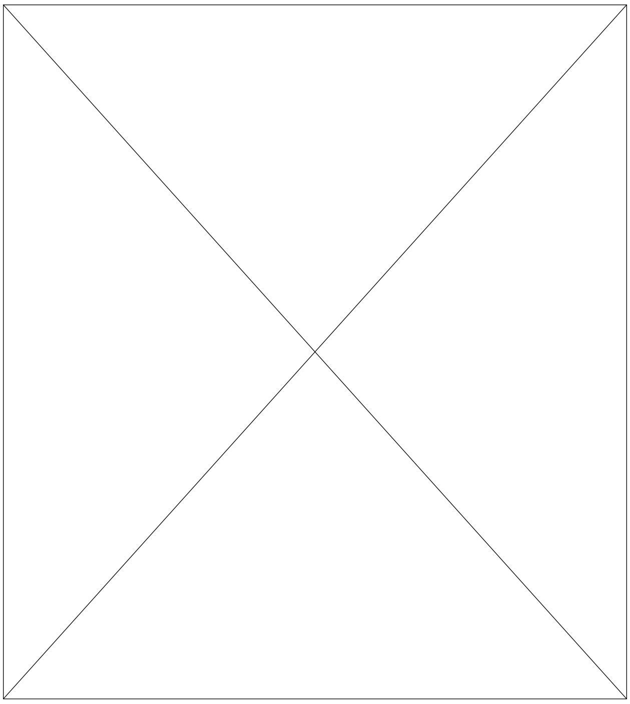

Figure 4. Surgery on a python under light general anaesthesia (Photo: Taronga Zoo).

Reptiles are resistant to hypoxia and slow or stop respiration when exposed to volatile anaesthetics. This may make induction chambers extremely slow or ineffective. Plastic bags can be used as makeshift induction chambers or face masks.

Precautions:
Chilling to below its preferred temperature may predispose a reptile to serious infection and may cause neurologic injury.

Any drug that may be nephrotoxic should be administered in the cranial third of the body so that potentially toxic concentrations do not pass through the kidneys via the renal portal system before entering the general circulation.

Avoid inserting an endotracheal tube too far, especially in chelonians, otherwise the tube may enter a bronchus and block access to the other lung.

Methods:
Minor surgical procedures can be carried out with local infiltration of two percent lignocaine without epinephrine. Good physical restraint or the use of light general anaesthesia is also required.

Ketamine hydrochloride can be administered i/m or i/p at 15-20 mg/kg, depending on the species and depth of anaesthesia required; 25 mg/kg is sufficient for many operative procedures. Induction normally takes 10-30 minutes, with early arousal about 45 minutes later. The i/p route is very useful in chelonians and in aggressive or venomous snakes. Disadvantages are that large volumes are required, induction can be long (30-60 minutes) and recovery can be very prolonged (24 hours or more) at higher dose rates. Rarely, tonic muscular rigidity or even tonoclonic spasms occur, but these can be abolished with diazepam, although this will deepen and prolong anaesthesia. Ketamine is detoxified and cleared via the kidneys, and its use is contraindicated if renal insufficiency is suspected.

Tiletamine/zolazepam (10-30 mg/kg i/m) is preferred to ketamine and provides excellent muscular relaxation. Arousal occurs about an hour after administration. However, once constituted, it can only be used up to four to five days later, and then only if kept refrigerated and in the dark. Similar precautions to the use of ketamine (renal insufficiency) and diazepam (with the concurrent use of invermectin) hold.

Inhalation anaesthesia is the method of choice (isoflurane is preferable to halothane). Reptiles can hold their breath for prolonged periods, during which they employ anaerobic respiration. Induction can therefore be prolonged. Some chelonians and lizards are difficult to intubate. Snakes, lizards and small crocodilians can be intubated while conscious, then anaesthetised with intermittent positive pressure ventilation at four to six breaths per minute. The glottis is very accessible and a suitably sized endotracheal tube can be inserted when the animal inhales. Induce at three to five percent and maintain at one and a half to three percent.

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